1235 173

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(54) CYLINDER STRUCTURE OF PISTON COMPRESSORS OR PUMPS

(71) We, MASCHINENFABRIK BURCKHARDT A.G., a Swiss Corporation of Dornacherstrasse 192, Basel, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to an improvement in the cylinder structure of a single or multi-stage piston compressor or pump, especially compressors operating at very high pressures, eg. several thousand atmospheres.

For compressors operating at very high pressures, preferably cylinders of composite construction are used. The actual cylinder bore within which the piston stroke takes place is usually in a barrel with an inserted liner or containing rings forming annular chambers to receive packing elements if a plunger form piston is used. In order to carry away the heat produced in the cylinder, the barrel or chambers are often provided with grooves or flutes for the reception of cooling fluid. For centreing, the cylinder barrel is set in an outer tube secured to a thick base plate, which tube can also serve as a cooling jacket. By means of long anchor screw members secured in the base plate, the cylinder barrel or the stack of chamber-forming rings, set centrally in the outer tube, and the cylinder head for receiving the suction and delivery valves, which valves can be concentrically arranged as a unit, are combined into a cylinder structure. To impose the preloading necessary for fluid tightness, the anchor screw members are pretensioned by the aid of high pressure oil pumps through suitable devices of known kind.

The securing of the cylinder structure to the driving gear framework is usually effected by the cylinder base plate constructed with a connecting flange or by the cylinder head constructed with a connecting flange, the assembled cylinder structure then being centrally guided in a frame which is either separately flanged on to or cast integrally with the driving gear framework.

The suction and delivery valves, preferably of the same dimensions, are mounted on the end surface or on both sides of the cylinder head and have lenticuler sealing surfaces which are pressed against a cylinder inner core member by connecting members provided with flanges. The suction and delivery pipes are connected to the flanges of the connecting members.

In the operation of compressors having the cylinder structure built up as above described, in dismantling, e.g. for exchange of the valves, removal of the cylinder barrel, sealing and so forth, a considerable time is taken in removing the cylinder head and pipe connections, which in most cases is a serious interruption in the operation of a chemical process and also involves considerable cost for the loss of production involved.

A purpose of the present invention is to provide a cylinder structure of a high pressure compressor or pump which has the advantage over the known constructions of the possibility of rapid assembly and dismantling of the cylinder inner parts, such as cylinder barrel, valves, packing elements and so forth, thus to reduce the time necessary for the purpose to an acceptable value.

A structure in accordance with the invention comprises a cylinder housing constituting a unit consisting of a head portion having the necessary passages for suction and delivery conduit connections, a bottom closure with an upwardly facing bearing surface, and an intermediate portion having a bore receiving and centreing an assembly of inner parts, consisting at least of parts defining a cylinder bore, in which in use a piston reciprocates, and with provision for communication between the space above the piston with the said passages, in which the assembly of inner parts is clamped between the bearing surface and an upper closure member screwed into the upper end of a bore in the head portion with longi-

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tudinal elastic extension in the said intermediate portion, thereby enabling said cylinder inner parts to be assembled or dismantled without removal of said suction and delivery conduits.

Further developments of the invention will appear from the following description in which reference is made to the accompanying drawings in which examples embodying the invention are illustrated in the drawings:—

Figure 1 is a longitudinal section of a high pressure cylinder structure having a housing receiving the cylinder inner parts, made in one piece, containing an uncooled cylinder barrel, piston and piston rings and suction and delivery valves pressed laterally against a cylinder inner core member;

Figure 2 is a longitudinal section of a high pressure cylinder structure having a cylinder housing made in one piece, containing chamber forming rings with packing elements and containing concentric suction and delivery valves;

Figure 3 is a longitudinal section of a high pressure cylinder having a cylinder housing comprising a bottom closure of plate form, centreing tube and cylinder head member held together by anchor screw members, containing chamber forming rings with packing elements, and a central valve unit which is set concentrically in a cylinder inner core member, the left hand side of the figure showing the possibility of making connection for the medium to be compressed or pumped to the core member and the right hand side the possibility of making connection for the medium laterally to the head member;

Figure 4 shows a particular embodiment of the upper closure member used in Figures 1 to 3; and

Figure 5 a section of the threaded part of the upper closure member and cylinder member and cylinder receiving housing of Figures 1 and 2 or the head member of Figure 3.

The terms "upper", "top", "bottom" and the like are used herein solely for convenience, assuming the cylinder is used with its axis vertical and the piston below the valves but the invention is not limited to this attitude.

In the example shown in Figure 1, a cylinder guiding frame is marked 1, into which a one piece cylinder housing 2 is inserted coaxially. To enable the cylinder receiving housing 2 easily to be pressed in, as shown on the left hand side of Figure 1 the external diameter of the parts which seat in the frame are stepped, i.e. the external diameter of the guide collar 42 on the lower part of the housing 2 is smaller than the guide diameter 5 of the upper part forming the head portion. If the cylinder construction permits however, the lower end portion of the housing 2 can project without a guide surface at 42 freely into the frame 1 as shown on the right hand side of Figure 1. To permit unhindered expansion of the housing 2 in the direction of the cylinder axis in particular under the effect of the heat developed in operation, securing of the housing is effected by bolting a flange 70 at the upper end of the housing to the upper end of the frame 1. This flange can as Figure 1 shows be unitary with the housing 2, but it is also possible to shrink it on or make it as a loose flange.

The bottom closure of the housing 2 can as shown on the left hand side of Figure 1 be made in one piece with the rest of the housing, the inner end surface for abutment of the internal cylinder parts being of suitable form for good transmission of forces, e.g., with a part spherical hollowing 11. In cases where however the dimensions of the housing 2 cause difficulties in machining the inner end surface of an integral closure or makes machining impossible, a separate closure member 9 threaded at 10 can be screwed in, as shown on the right hand side of Figure 1. The separate closure 9 is also provided with a hollowing 11 for good transmission of forces.

The cylinder housing 2 between the lower guiding collar 42 and the upper guiding part 5 incorporates an intermediate wall portion 3 extending over a predetermined length, the outer diameter of which is less than that of the collar 42 so as to give this portion a smaller cross section than the rest of the housing, the value being calculated to give a predetermined longitudinal elastic extension under the preloading of the parts of the cylinder structure required to clamp the cylinder inner parts. On the inside of the bottom closure of the housing 2 is provided a spacer member 12 which at the end towards the cylinder barrel 13 has a flat bearing surface and at the opposite end a curved surface matching the hollowing 11 in the bottom closure of the housing 2.

The cylinder barrel with inset cylinder liner 14 presenting the bore for a reciprocating piston 43 having piston rings 44 as moving packing elements, is set in a central bore 4 in the housing 2. When it is set against the flat end surface of the spacer member 12, the latter is centred by the action of its spherically curved bearing surface co-operating with the hollowing 11, so that the lower end surface of the cylinder barrel 13 bears all round against the flat end surface of the member 12.

Instead of the cylinder parts 13, 14 of Figure 1, an arrangement known *per se* comprising a stack of annular chamber-forming rings accommodating packing elements may be used. Such an arrangement is shown in Figure 2 and comprises an upper ring 47, chamber forming rings 48, packing elements 49 and a lower ring 50, for coaction with a reciprocating plunger type piston 51, the cylinder housing here being marked 46.

In place of the cylinder housing 2 of Figure

1 or 46 of Figure 2, a cylinder housing of composite structure can be used as shown in Figure 3. Here a bottom end closure 76 of plate form together with a coaxial centreing tube 79 having its end inserted in the plate and serving to receive the inner parts of the cylinder, for example the chamber forming rings 48 with packing elements 49 for co-operation with a reciprocating plunger type piston 51 and a core member 83 with a central valve assembly 85, is secured by long anchor screw members here in the form of studs 77 and nuts 78 to an upper head member 75. The studs have long waisted shafts and their number and the dimensions of their waisted shafts are calculated to provide the necessary longitudinal elastic extension in pre-loading the parts of the cylinder structure. The securing of the head member 75 on the upper end surface of the guide frame 74 is effected by studs 81 and nuts 82.

In Figure 1 in a corresponding manner, the core member 15 having lateral passages 33 is so set on the upper end surface of the cylinder parts 13, 14 that the passages 33 register with lateral bores 6 in the housing 2 and guide frame 1.

The top closure for the core member 15 (in both Figures 1 and 3) is formed by a vertical inserted closure member 16 constructed as a hydraulic clamping piston of stepped form having a larger diameter piston portion 17 and a smaller diameter portion 18 which projects into a corresponding stepped guide bore in the lower part of an upper closure member 26 of screw form. The chamber 23 left between the upper annular surface of the piston portion 17 and the surface facing it of the member 26 receives hydraulic pressure from an external source, and the stepped bore in the screwed closure member 26 is provided with packings 19 and 20 of known kind. Pressure of the clamping piston 16 in relation to the core member 15 is effected by the aid of a central screw thread 25 in the member 26, into which screws a pressure screw 24. Supply of hydraulic pressure to the chamber 23 can be effected, as shown by way of example in the drawing, by a pipe connection 22 coaxially disposed in a bore in the pressure screw 24 and screwing into the member 16 and a passage 21 communicating with the chamber 23. After assembly of the cylinder inner parts, the upper end of the cylinder housing 2 is closed by the closure member 26 which is screwed in axially into a thread 7 in the head portion. So that the cylinder inner parts can be pushed into the bore 4 in the housing 2 without impediment, the inner diameter of the closure screw thread 7 is made of larger diameter than the diameter of the bore 4.

To permit rapid removal of the closure member 26 it has an interrupted screw thread on the lines shown in Figures 4 and 5. The thread machined with its parts as parts of a continuous thread is divided by a peripheral groove 71 having a base diameter a little less than the core diameter of the thread, into two parts 7 and 8, the part 8 comprising a few turns of continuous thread over the whole periphery to ensure accurate meshing of the other part 7. The part 7 is provided with longitudinal grooves 69 of such a depth that they extend slightly below the core diameter of the thread. The thread zones alternating with the grooves are uniformly distributed and the grooves are slightly wider than the thread zones. The thread in the housing 2 or 46 is similarly interrupted by grooves over the whole length, with the grooves slightly wider than the threaded zones left. By aligning the threaded zones on the member 26 with the grooves in the housing, the member 26 can be entered directly axially until the part 8 reaches the mouth of the housing, whereupon the member can be screwed in, the continuously threaded part 8 ensuring that the threads in the interrupted zones will correctly mesh. Full mesh can be obtained in only a fraction of a turn and then after each further fraction represented by the annular width of one groove plus one zone. Full mesh may be indicated by registration of marks on the screw member 26 and the end face of the head portion of the housing.

In Figure 1 the separate suction and delivery valves are respectively marked 27 and 28. These valves are mounted by connecting members 36 made externally as pipe couplings pressing flat surfaces 34 at the inner ends of the valve assemblies so firmly against corresponding sealing surfaces on the core member 15 that metal to metal sealed joints are made, the surfaces being suitably machined for the purpose. Pressing of the connecting members 36 is effected through flanges, which may be integral as shown in Figure 1, which are held by studs 37 and nuts 38 on the outside of the guide frame 1. To enable the members 36 to be withdrawn a screw nut 39 screwing on a thread 40 on the member can engage an abutment surface 72 on the frame 1. So that the suction valve 27 or delivery valve 28 is positively retracted radially with the connecting member 36 when the latter is retracted, the valve is carried in an enclosing sleeve 29 which by a thread 30 is screwed on to the connecting member. So that when the connecting member has not been drawn up tight, e.g. during its withdrawal, the preferably convex sealing surface 35 of the valve 27 or 28 of Figure 1 may remain pressed against the corresponding concave surface of the connecting member 36, in the intermediate space between a bead 31 in the sleeve 29 and a corresponding reduced diameter portion of the valve, a spring 32 is inserted of such dimensions that in screwing up the sleeve 29 on the thread 30, the spring is positively stressed, so that the valve is constantly urged radially outwards.

Mounting of the cylinder parts in the example of Figure 2 is effected similarly to that of the parts in Figure 1. The only difference is that instead of the individually mounted valves 27 and 28 in the frame 1, assemblies of known kind with concentric suction and delivery valves are used which are included among the cylinder inner parts, comprising for example the parts 52 to 60 of Figure 2, the suction valve assembly comprising a body 52, the actual annular valve plate 53, seating ring 54 and spring 55, and the delivery valve assembly which is arranged above the suction valve assembly with the interposition of an intermediate body 56 comprising a body 57, the actual valve member 58, valve spring 59, and a further body 60. With this arrangement the connections for the supply and delivery conduits are provided by the bodies 57 and 60 of the valve assembly and separate inserts 66, flat inner end surfaces 67 on these inserts being pressed through connecting members 62 made externally as pipe couplings, against corresponding sealing surfaces machined on the bodies 57 and 60, hard enough to ensure a metal to metal seal. As with the separate valves 27 and 28, here each insert 66 is retained by a separate sleeve 63 which is screwed on to a thread 64 on the member 62, the enclosed stressed spring 32 pressing the insert 66 at all times against the seating surface 68 which can for example be of concave shape, the sleeve 63 ensuring that upon retraction of the member 62 the insert 66 is positively retracted with it.

The mounting of the cylinder inner parts in the arrangement shown in Figure 3 is effected similiarly to that of the inner parts in Figures 1 and 2. The only differences is that the central valve 85 of known kind contains the suction and delivery valves in a unit in contradistinction to the assemblies of Figure 2, which unit is coaxially slidable in a cylindrical bore in a core member 83. Pressing of the central valve unit 85 against a seat 94 on the upper cylinder ring 47 can be effected by a spring member, for example a spring 87 which when the clamping piston 16 is inserted is given a predetermined load. An annular packing 86 of known kind is set between the annular space 93 which in the arrangement shown by way of example is under delivery pressure and the annular space 92 which is under suction pressure, to obtain tightness between the two spaces.

Clearly there would be no change in principle in mounting the parts if in place of the central valve unit 85 in Figure 3, set in a core member 83, concentric suction and delivery valves as in Figure 2 were used.

Connection to the conduits for the supply and delivery of medium to and from the core member 83 can as shown on the left hand side of Figure 3 be effected by means of connecting members 62 and intermediate members 66 held by sleeves 63, which intermediate members are pressed into sealing contact in a manner corresponding to that above described with reference to Figure 2.

However to achieve simpler assembly and dismantling of the cylinder inner parts the connections for the medium can be made laterally to the head portion 75 in the manner shown on the right hand side of Figure 3.

In this arrangement the zones of the outer surface of the cylindrical core member 83 into which open radial passages 95 leading from the inner annular spaces 92 and 93 and which communicate with the lateral further passages 89 in the head portion 75 are so sealed from one another by inserted packings 88 of known kind engaging the bore of the housing and located between the passages 95 and above and below the latter that no leakage of medium can occur along the inner part of the core member wall between the zone under suction pressure and the zone under delivery pressure, nor any leakage along the outer parts of the core member wall to atmosphere from the zone under suction pressure or from the zone under delivery pressure.

The connections for the supply and delivery conduits for the medium can then be made at the lateral surface of the head portion 75, as shown on the right hand side of Figure 3, in known manner by threaded flanges 91 with the interposition of lenticular form sealing elements 90.

Assembly and dismantling of the cylinder inner parts with the arrangements of Figures 1 to 3 is effected in a short time as follows:—

For dismantling, the nuts 38 are loosened and unscrewed until the connecting member 36 of Figure 1 or 62 of Figure 2 left hand side to which the conduit for supply and delivery of the medium is coupled, can be moved back at least through the distance *a* (Figure 1). By rotating the nuts 39 on the thread 40 using a lever 41, the members 36 or 62 are retracted until the projecting ends of the suction and delivery valves in Figure 1 or of the inserts 66 of Figures 2, and left hand side of Figure 3, projecting into the bore 4 are withdrawn at least through the distance *a* thereby freeing the bore 4 in the housing 2 of Figure 1 or 46 of Figure 2 or in the head portion 75 of Figure 3 for pushing out the cylinder inner parts.

Through the loaded springs 32, the valves 27 and 28 in Figure 1 and the inserts 66 in Figures 2 and 3 remain pressed against the sealing surfaces 35 or 68 of the connecting members 36 or 62. The pipe conduits extending from the flanges of the members 36 or 62 will in general (as by the inclusion of bowed sections) have so much flexibility that the forces necessary for withdrawal of the member 36 or 62 through the required distance can be exterted without difficulty through the nuts 39 and lever 41.

Thereafter through the pipe connections 22 and passage 21 a hydraulic pressure is supplied to the chamber 23 of such value that under the force exerted through the annular surface formed in the chamber between the portions 17 and 18, of the clamping piston 16 of Figure 1 or 61 of Figures 2 and 3 and transmitted through the assembled cylinder inner parts, the cylindrical part 3 of the housing 2 of Figure 1 or 46 of Figure 2 or the shafts of the anchor studs 77 of Figure 3 are downwardly elastically extended under tension. The clamping pressure acting through the bottom end surface 45 of the central screw 24 is thus relieved and the screw 24 can without difficulty be screwed back a few turns. After release of the hydraulic pressure in the chamber 23, the preloading of the screw threads 7 of the closure screw 26 is relieved. This is accomplished by first rotating screw 26 by an amount sufficient to disengage the completely threaded part 8, thereafter the interrupted threads of the part 7 are brought into alignment with the complementary grooves, which can be done rapidly and without difficulty, and the screw 26 is directly withdrawn axially from the housing 2 carrying the screw 24 still screwed into it, whereafter the inner parts can be removed upwardly.

For removing the valves 27 and 28 in Figure 1, after removal of the screw member 26, the closure piston 16 and the cylinder core member 15, a special tool *eg* a hexagon socket spanner is passed through the cylinder bore 5 into the bore 6 of the housing 2 and over a corresponding hexagon formation 73 on the sleeve 29 projecting into the bore 6, and the sleeve is rotated to unscrew it from the thread 30 of the connecting member 36. After removal of the sleeves 29, the valves 27 and 28 can be removed through the bore 5 without difficulty.

To remove the cylinder inner parts in the arrangements of Figure 2 and the left hand side of Figure 3 the procedure is the same as described above with reference to Figure 1. With central suction and delivery valves as in Figure 2 and the left hand side of Figure 3 there is a simplification in that the central valves can be moved upwardly directly out of the housing 46 of Figure 2 or head portion 75 of Figure 3 with the other cylinder inner parts after the connecting members 62 with the intermediate members 66 have been retracted through the distance *a*.

A still further simplification in dismantling is obtained with the arrangement shown on the right hand side of Figure 3 in that retraction of the connecting members through the distance *a* is not needed.

Assembly of the cylinder parts of Figures 1 to 3 is effected by proceeding in the reverse manner to that described for dismantling.

After screwing the sleeves 29, with the springs 32 and valves 27 and 28 in place, on to the thread 30 on the connecting members 36, care must be taken that the sealing surfaces 34 are so far retracted into the bores 6 that the valves do not project into the path of the parts 13 and 15 as they are brought into the housing 2. This retraction is ensured by rotating the nuts 39 by the lever 41. Thereupon the cylinder inner parts are inserted in the order 12, 13 and 15, and the clamping piston 16 is then placed in position.

After this, the screw member 26 is directly axially inserted into the upper end of the cylinder receiving housing, with the grooves and interrupted threads correctly aligned until the uninterrupted threaded part 8 reaches the top of the housing. The member 26 is now screwed in until the pressure surfaces of the chamber 23 about. After this abutment the screw member 26 is turned back until the mark on its upper end surface registers with the mark on the cylinder housing flange showing that the threaded portions of the interrupted threads on the screw member and in the housing are in full mesh and can be subjected to loading. During the insertion of the screw member 26 the piston portions 17 and 18 of the closure piston 16 (or 61) are engaged with the packing rings 19 and 20 of known kind located in the bores on the lower end of the screw member.

The pressure screw 24 up to now has not yet come into contact with the upper end surface 45 of the piston portion 18. By means of hydraulic pressure (admitted through 22, 21 to the chamber 23) of a value exactly corresponding to the preloading of the cylindrical intermediate portion 3 of Figures 1 and 2 or of the shafts of the anchor studs 77 of Figure 3 required to exert the clamping force, the cylinder closure 9 of Figure 1 or 46 of Figure 2, or 76 of Figure 3 is carried downwardly by elastic extension of the intermediate portion or of the studs, the clamping piston 16 of Figure 1 or 61 of Figures 2 and 3 being carried downwardly by the same amount. After reaching this predetermined hydraulic pressure, the central screw 24 is screwed in until its lower end surface abouts the end surface 45 of the piston portion 18, which can be effected without any heavy forces being exerted.

If the hydraulic clamping pressure in the chamber 23 is now released the preloading in the portion 3 of the housing 2 or 46, or in the shafts of the anchor studs 77 is now transferred from the thread 25 of the pressure screw 24 and from the engaged zones of the thread 7 to the closure screw member 26. In this way the screwed parts 24 and 26 are put under preload and owing to the high forces necessary to overcome the friction between the loaded threads, they will not loosen during operation of the compressor.

After assembly of the cylinder parts in the manner above described the nut 39 on each connecting member 36 of Figure 1 or 62

of Figure 2 or the left hand side of Figure 3 is screwed back until it is clear of the bearing surface 72. Thereafter the flange of the connecting member is drawn up by the aid of the nuts 38, whereby the member 36 or 62 is pushed in the direction towards the cylinder until good sealing pressure is reached at the sealing suraces 34 of Figure 1, Figure 2 and Figure 3 left hand side.

WHAT WE CLAIM IS:—

1. A cylinder structure of a high pressure compressor or pump, said structure comprising a cylinder housing constituting a unit consisting of a head portion having the necessary passages for suction and delivery conduit connections, a bottom closure with an upwardly facing bearing surface, and an intermediate portion having a more receiving and centreing an assembly of inner parts consisting at least of parts defining a cylinder bore, in which in use a piston reciprocates, and with provision for communication between the space above the piston with the said passages, in which the assembly of inner parts is clamped between the bearing surface and an upper closure member screwed into the upper end of a bore in said head portion, with longitudinal elastic extension in the said intermediate portion, thereby enabling said cylinder inner parts to be assembled or dismantled without removal of said suction and delivery conduits.

2. A cylinder structure according to claim 1, in which the said intermediate portion includes a port capable of appreciable longitudinal elastic extension of substantial length and in one piece with said upper head portion and with a lower end portion integral with or having screwed into it said bottom closure, and which is of smaller cross section than either said upper portion or said lower end portion.

3. A cylinder structure according to claim 1, in which the said intermediate portion comprises long waisted shafts of screw members in tension connecting said bottom closure to said upper head portion and capable of appreciable longitudinal elastic extension, and a centreing tube holding said bottom closure and upper head portion spaced and providing part of said bore receiving said cylinder parts.

4. A cylinder structure according to claim 1, 2 or 3, in which said cylinder housing is separate from but attached to a support frame in which it has a sliding fit.

5. A cylinder structure according to any preceding claim, in which the screw thread on said upper closure member is divided into an upper peripherally continuous portion of only a few threads, and a lower portion capable of taking substantially the whole clamping load extending to its lower end having the threads interrupted by longitudinal grooves slightly deeper than the threads and uniformly distributed round the axis with the grooves slightly wider than the threaded zones and the thread in said head portion is interrupted to match so that the closure member can be inserted by a direct axial movement until said upper peripherally continuous portion reaches the mouth of the threaded opening in said head portion and only a fraction of a turn is necessary to achieve full meshing, the thread on said peripherally continuous portion serving to ensure correct meshing.

6. A cylinder structure according to any preceding claim in which a pressure screw screws into a coaxial hole in said upper closure member, the inner end surface of which bears against a coaxial clamping piston so that the pressure exerted on the clamping piston when this pressure screw is screwed in is transmitted from the clamping piston through the cylinder inner parts to the bottom closure of the cylinder housing, said portion capable of longitudinal elastic extension being thereby pre-loaded and elastically extended.

7. A cylinder structure according to claim 6, in which the clamping piston is of stepped form and a chamber is left between an upper surface of the clamping piston and a surface within said upper closure member, a passage extending from the chamber to the exterior whereby connection can be made to an external source of hydraulic pressure.

8. A cylinder structure according to claim 7, in which said passage extends by a pipe connection coaxially disposed in said pressure screw.

9. A cylinder structure according to any preceding claims, in which said internal bearing surface of said bottom closure is of concave part spherical form.

10. A cylinder structure according to any preceding claim, in which separate suction and delivery vales are located in lateral bores in the head portion, and are each clamped between a cylinder core member constituting one of said cylinder inner parts and a connecting member projecting into the respective latral bore.

11. A cylinder structure according to claim 10, in which each valve is carried within a sleeve secured to the respective connecting member and is under the action of a spring in the sleeve which constantly urges the valve radially outwards.

12. A cylinder structure according to any of claims 1 to 9, in which said inner parts includes concentric suction and delivery valves, and in which supply and delivery passages from the valves each pass through an insert which is carried within a respective sleeve secured to a respective connecting member and is under the action of a spring in the sleeve which constantly urges the insert radially outwards.

13. A cylinder structure according to claim 11 or 12, in which each connecting member is provided on a thread with a screw nut

positioned to enable it to abut against an external surface of the said structure so that by screwing up the screw nut the connecting member with the sleeve can be retracted in a direction away from the cylinder axis.

14. A cylinder structure according to any of claims 1 to 9, in which suction and delivery valves constituting a concentric unit are located within a member forming one of said cylinder inner parts, annular spaces within said member forming connections between the respective valves and radial passages within said member leading from said annular spaces and registering with further passages in said head portion leading to connecting members for attachment of supply and delivery conduits, said member carrying packing means engaging said bore of said intermediate portion between and above and below said radial passages.

15. A cylinder structure of a high pressure compressor or pump substantially as described with reference to Figures 1, 4 and 5 of Figures 2, 4 and 5 or Figures 3, 4 and 5 of the accompanying drawings.

SEFTON JONES, O'DELL &
STEPHENS,
Chartered Patent Agents, Beacon House,
113, Kingsway, London, W.C.2.
Agents for the Applicants.

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Sheet 1

Fig. 1

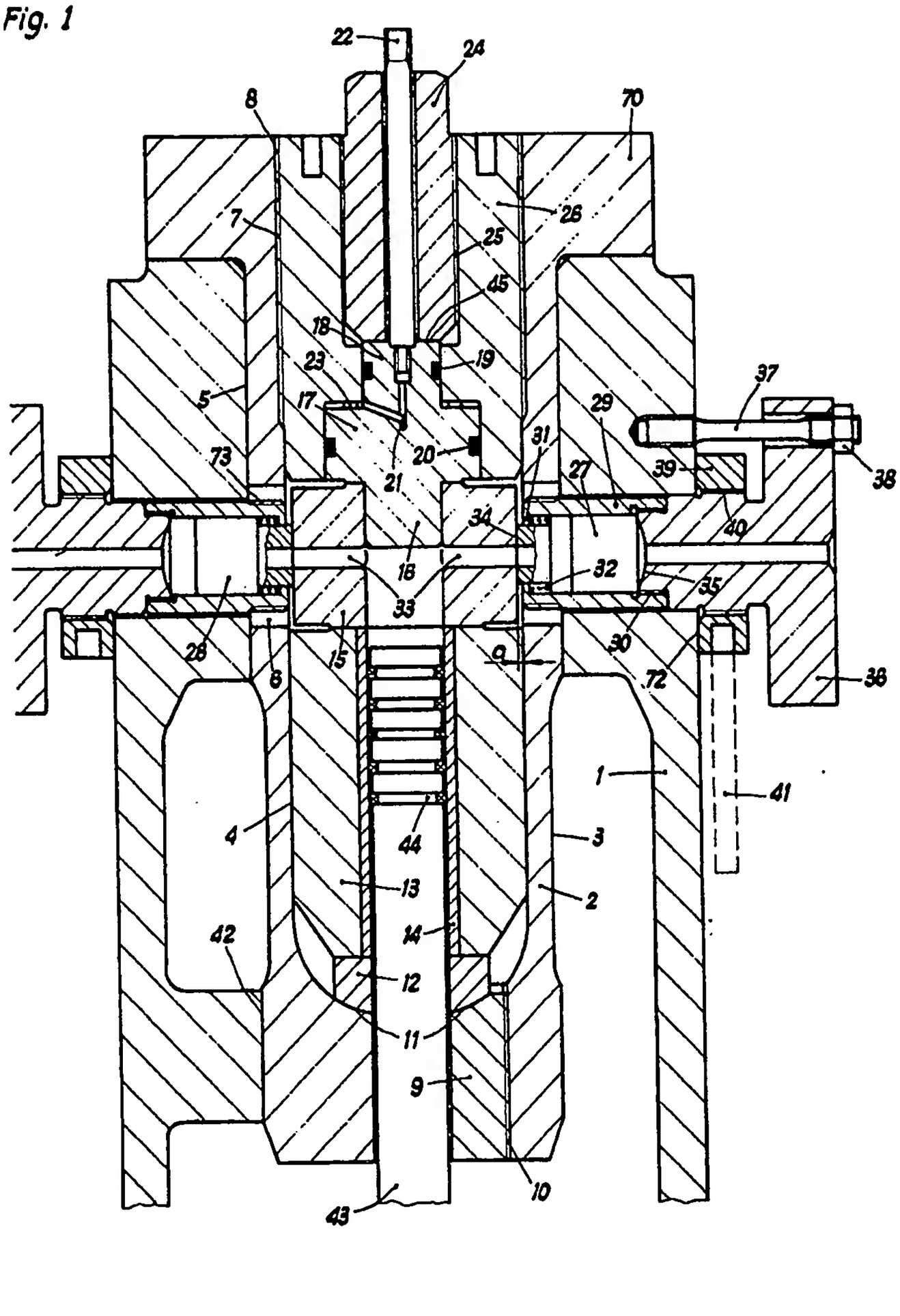

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Fig. 2

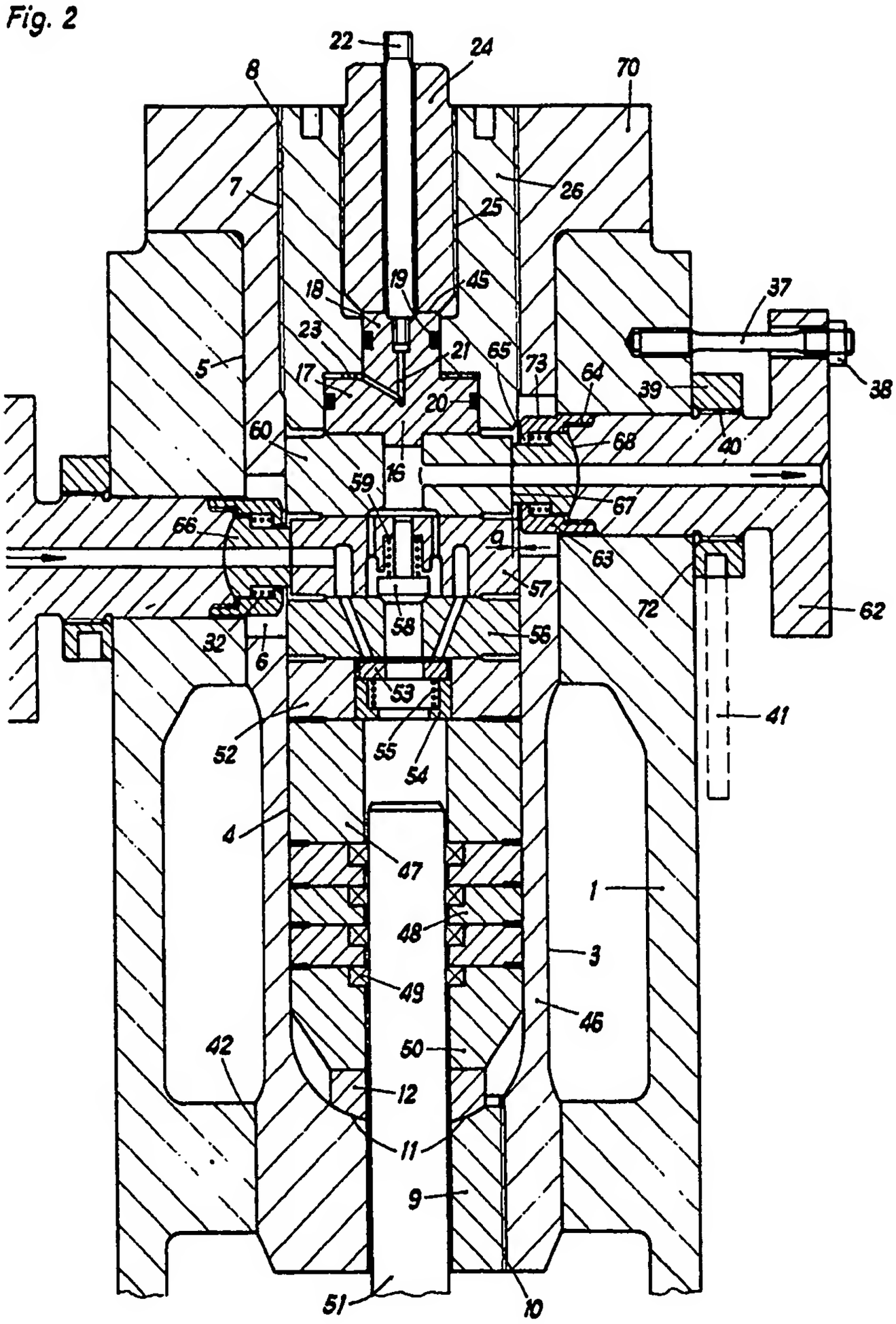

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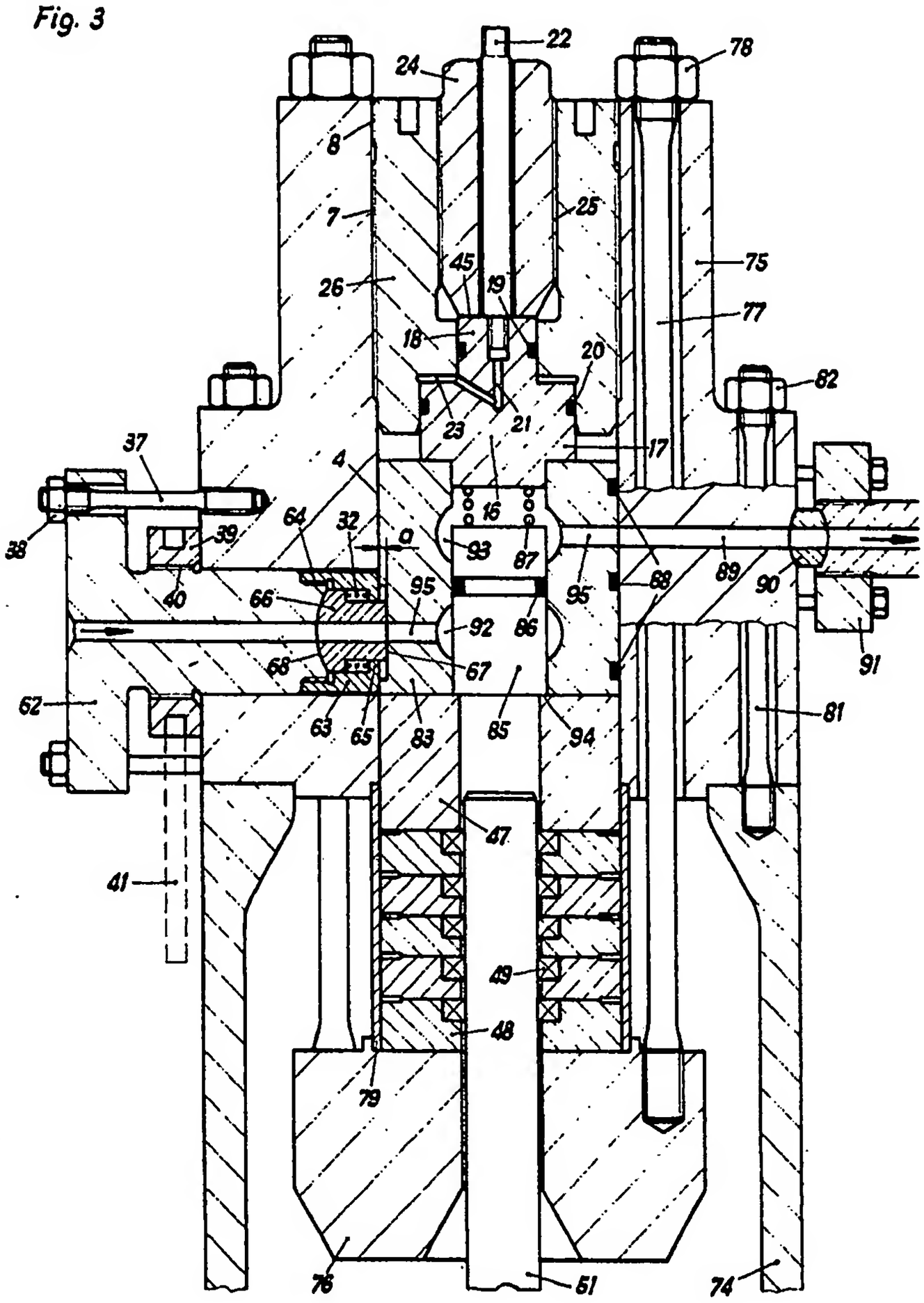
Fig. 3



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Sheet 4

Fig. 4

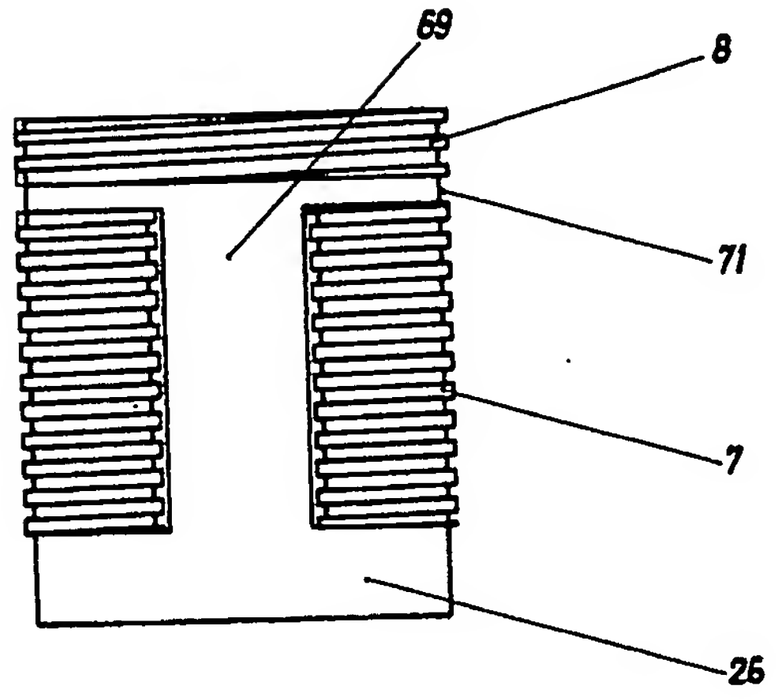

Fig. 5